Selection filters, redistributive taxation and overconfidence

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Abstract

Education can be a filter that solves an assignment problem. We consider what this implies for redistributive taxation in the political process. First we assume that all individuals have undistorted expectations about their abilities. Then we analyse populations in which some group of workers is overly confident. The overconfident are more successful, but enjoy lower utility. Just confident workers benefit from overly confident workers. Also, the preferences of just confident workers for redistribution do not necessarily exceed those of overconfident workers.

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1 Introduction

An important theory on education suggests that education mainly serves as a filter: individuals who have a higher intrinsic ability pass the exams that are the hurdles in education tournaments, at least they pass with a higher probability, whereas individuals with inferior ability do not, or are

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less likely to pass. This point of view has been made forcefully by Arrow (1973). He discusses that filtering could enhance the productivity of the economy, even if it does not change an individual's own abilities, because education filters can sort individuals according to their abilities that makes it easier to assign them to tasks in which they have productivity advantages. Individuals may spend effort to find out whether they are suitable for a particular task or not, and one should expect that, the more effort they spend the more precise is the information they receive about their particular ability. The assignment function of filters can enhance the overall efficiency of the economy. The theoretical and empirical importance of assignment problems in the labor market have impressively been documented in Sattinger (1993). However, the income dispersion caused by assignment problems and the issue of redistributive taxation has received far less attention in this context than in the context of human capital formation.

In this paper we consider education filters as a solution of the assignment problem. We concentrate on the role of redistributive taxation and on psychological misperceptions about own ability, particularly the role of overconfidence, and how these misperceptions and redistributive taxation interact. To analyse these questions, we consider a framework that is related to Arrow's (1973) assignment problem in section 2 and describe the laissez-faire equilibrium in the absence of overconfidence in section 3. There are two tasks. The easy (or less demanding) task can be performed by everyone equally well. There is also a difficult (or more demanding) task that can be performed productively only by a share of the work force. Individuals can spend filtering (education) effort and try to pass an examination. If they are successfully passing the exam, thereby they produce a signal that makes it more likely that they are able to perform the difficult task. An important aspect here is that there is a spillover from individual investment in this filter.[1] Typically education investment generates a positive externality, because more filtering effort improves the precision of the signal.

Filtering also causes income dispersion, and this gives a role for redistributive taxation that is considered in section 4. As discussed in related contexts (e.g., Varian 1980, Sinn 1996), if some education choices lead to some ex-post inequality in income, and if private insurance is difficult to obtain, redistributive taxation has the role of insurance from an ex-ante point of view when individuals do not know yet whether they will end up with low or

[1] Macroeconomic spillovers of education have also been considered if education is not a filter, but a productivity enhancing investment. One example is human capital as an engine of endogenous growth. A more sophisticated example is Fisher and Keuschnigg (2000) who consider optimal taxes and subsidies for different types of human capital acquisition if human capital acquisition has externalities.

high income.[2] As examination success but not eduation effort is observable, there is a trade-off for redistributive taxation. This trade-off is somewhat different from a standard incentive problem, because education effort has a filter externality here: an individual's increased filter effort increases the average quality of all individuals who pass the filter. Redistributive taxation may have a first-order welfare benefit because it provides some insurance, but it also has a first-order efficiency cost, as even the first unit of redistribution will reduce filtering effort, starting from a laissez-faire equilibrium level that is already suboptimally low. We will consider redistributive taxation from the perspective of political economy in which the median voter chooses the amount of redistributive taxation[3] and compare it with the choice of a welfarist government.[4] An important element of the analysis will be that the society or the political process can commit to the choice of the redistributive tax that is made when individuals have not yet made their effort choices and when it has not turned out whether they succeeded or failed in the filter.[5]

Empirical evidence suggests that individuals differ in their perceptions about their own expected ability. Individuals' self-evaluation is often strongly biased: many individuals are overconfident about their own abilities. Some sources of empirical evidence will be cited in section 5 when overconfidence is

[2]Related to redistributive taxation, Agell and Lommerud (1992) consider wage compression as an insurance device. The results on education as a filter and on overconfidence carry over to their framework.

[3]Redistribution is determined by the political process. The political economy literature on redistributive taxation is briefly surveyed in Drazen (2000). Voters' preferences about future redistributive policies depend on their perceptions about future income risks and their future income position (see, e.g., Glazer and Konrad 1994, Drazen 2000, p.315n., Benabou and Ok (2001)). In this paper we will consider on the political economy of redistributive taxation, but we will also ask how the political economy equilibrium compares to the choice made by a welfarist government.

[4]In the literature on productivity enhancing education and optimal taxation, Hamada (1974), for instance, suggest that use of a combination of subsidies and redistributive taxation can yield an outcome as close as desired to the first best. However, subsidies require that educational subsidies are observed. Boadway, Marceau and Marchand (1996) highlight that time consistency problems may cause problems in the context of optimal income taxation and may lead to excessive redistributive taxation of human capital investment. They also suggest mandatory education as a remedy. Konrad (2001) adds on this, explaining why private information could be an incomplete remedy for the time consistency problem. A more complex multi-principal problem is addressed by Andersson (1996). He considers the state as a tax collector in an incomplete information framework in which the employer is a principal who extracts information about the worker's ability from observing the worker's signalling activities.

[5]This point needs to be emphasized as it is clear from Boadway, Marceau and Marchand (1996) that the outcomes differ from the commitment case considered here, and from each other, if commitment is not feasible and the time consistent tax is implemented.

introduced in the analysis. Overconfidence changes the laissez-faire equilibrium. Overconfidence leads to more filtering effort by both the overconfident and by individuals who are just confident. But overconfidence also has implications for optimal taxation. Overconfidence in the laissez-faire equilibrium and its implications for redistributive taxation are analysed in sections 5 and 6. Some assumptions and generalizations are discussed in section 7, and section 8 concludes.

2 The filter

Suppose there are two types of tasks in a society, and individuals differ in their intrinsic abilities. More precisely, there is a difficult task that can be performed well only by a share of all individuals. An individual who is able to perform the task is called a 'type-H' individual, and the output it generates by performing this task is h. We denote η the share of individuals who are able to perform the task. An individual who is not able to perform this task is called unable, or a 'type-L' individual. It produces zero if it tries to perform the task. The total population is a continuum of measure 1. Let $\mathcal{I}$ denote this set of all individuals, and $\mathcal{H} \subset \mathcal{I}$ and $\mathcal{L} \subset \mathcal{I}$ the sets of workers of type H and of type L that have measures η and $1-\eta$, respectively. There is also a second task that is less demanding. All individuals can perform it equally well, and each individual generates an output equal to m by performing this task.

Individuals choose their own effort x that can be considered as time input. This effort is aimed at producing a quality signal, e.g., passing an examination. For able individuals the probability of passing the examination is $F_H(x)$, with $F_H \in (0,1)$ increasing in x and strictly concave. Similarly, for unable individuals the respective probability is $F_L(x)$ and has similar properties. Moreover, we assume $F_H(0) \geq F_L(0)$ and $F'_H(x) > F'_L(x)$ for all x, that is, the filter is informative even for very low levels of effort, and its quality improves with increases in x.

Effort also has some cost. As we can normalize the units in which x is measured, we assume that x is normalized such that it has unit cost c. This cost is independent of individuals' types. Individuals do not know their own productivity, but know the true distribution of types. The share of workers who pass the filter given their choices x_i is

$$\varphi = \int_{i \in \mathcal{H}} F_H(x_i) di + \int_{i \in \mathcal{L}} F_L(x_i) di \tag{1}$$

If all workers (or a mass of one) choose the same x, we can determine the

share of workers who passes the filter. The share $\varphi(x)$ equals each individual's subjective probability of passing the filter, given this effort:

$$\varphi(x) \equiv \eta F_H(x) + (1-\eta)F_L(x).$$

We can also determine the share of workers in this group who are of type H. This share is

$$\alpha = \frac{1}{\varphi}\int_{i\in\mathcal{H}} F_H(x_i)di, \tag{2}$$

and, in the case in which almost all workers choose the same x,

$$\alpha(x) \equiv \frac{\eta F_H(x)}{\varphi(x)}.$$

Note that a single worker cannot influence φ nor α by his individual choice of effort. Competition will drive the wage in the less demanding task down to m. Wages in the more demanding task are more difficult to determine. The employers cannot observe the actual x chosen by an individual, but can observe whether the individual successfully passed the filter or not.

To rule out some less interesting cases in which all workers should be employed in only one of the tasks, we will assume that the competitive wage m in the less demanding sector is higher than the average productivity of workers who failed in the filter for all levels of filter effort, and that this m is smaller than the average productivity of workers who were successful in the filter, also for all levels of filter effort. This implies that the unsuccessful workers will always be employed in the less demanding task and the more productive workers are always employed in the demanding task. This assumption is mainly for simplicity, but also eliminates the possibility of a number of other equilibria.[6]

3 The laissez-faire equilibrium

Before introducing redistribution, consider the laissez-faire equilibrium of a game with the following timing. Workers form their beliefs about wages m and w in the two tasks. Next they choose their filtering efforts x simultaneously but independently of each other. Firms and workers then observe

[6] For instance, a zero-filtering effort equilibrium can be supported by appropriate out-of-equilibrium beliefs of firms if $m > h\alpha(0)$. If all firms think that a worker who passed the filter has a probability of being of type H that equals $\alpha(0)$, then it is indeed a rational strategy for each worker to choose $x = 0$, as the competitive wage offer in the demanding task then is $\alpha(0)h < m$.

who passed and who failed the filter. Firms make competitive wage offers to workers that can depend on the filtering result.

Suppose that all agents anticipate that a successfully filtered worker's expected productivity in the demanding task is $h\alpha$. Suppose further that labor contracts cannot condition on the individual productivity ex-post, for instance, because firms employ many workers and observe only aggregate outputs in the two tasks.[7] Then $w = h\alpha$ is the competitive wage offer in this task. In the less demanding task, the competitive equilibrium wage will be m in any case. A worker's expected utility is

$$EU(x; w, m) = [\eta F_H(x) + (1 - \eta)F_L(x)][u(w) - u(m)] + u(m)$$

at the stage when he anticipates these wages and makes a choice of x. The first-order condition that must be fulfilled in a symmetric interior equilibrium is

$$[\eta F'_H(x) + (1 - \eta)F'_L(x)](u(h\alpha(x)) - u(m)) = c. \tag{3}$$

The optimization problem is well-behaved from the perspective of the individual that takes w as given, as $\eta F_H(x) + (1 - \eta)F_L(x)$ is strictly concave. However, a multiplicity of equilibria cannot be ruled out without further assumptions, as $[\eta F'_H(x) + (1-\eta)F'_L(x)]$ decreases in x, but $(u(h\alpha(x)) - u(m))$ increases in x. In what follows we will adopt the first-order approach, assuming that the left-hand side in (3) is strictly decreasing in x leading to a unique solution x^*. All further consideration will be based on this first-order approach.

The equilibrium that is characterized by (3) exhibits an inefficiency:

Proposition 1 *Workers spend too little filtering effort in the equilibrium.*

Proof. Starting from the equilibrium in which (3) is fulfilled for all workers, a marginal increase in all workers' filtering effort increases their expected utility by

$$\varphi(x)u'(w)h\alpha'(x) > 0. \tag{4}$$

Hence, there is a macroeconomic externality of increased filtering effort and too little filtering effort from a welfare point of view. □

Intuitively, if a single worker increases his filtering effort, this increases his chances of successful filtering and of receiving the higher wage that is paid to successfully filtered individuals. This is the effect the worker takes into consideration. However, the increase in filtering effort also increases the performance of the filter: it increases the share of type-H workers among those

[7] Wage discrimination on the basis of ex-post performance measures is discussed in section 7.

who are successful in the filter, and this increases the average productivity of this group of workers.

4 Redistributive taxation

The workers face some income risk in the laissez-faire equilibrium and suffer from this income risk if u is strictly concave. From an ex-ante point of view, before they know whether they pass or fail the filter, they would like to insure against this income risk. However, any insurance also changes the incentives to choose filtering effort. As discussed in Varian (1980) and Sinn (1996) in the context of productivity enhancing investment in human capital, private insurance may be difficult to obtain in the education context[8] and redistributive taxation may substitute for private insurance. In what follows we will consider the choice of redistributive taxation in the absence of private insurance, but discuss private insurance more closely in section 7.

We consider the median voter making the choice on a redistributive regime before everyone chooses own filter effort and before workers learn about their success or failure in the filter. As there are only two types that can be distinguished ex post, there are not many degrees of freedom as regards the choice of the distribution policy. The government that has to carry through the chosen policy observes the type of task in which a worker is employed in the equilibrium. Hence, the redistributive policy must consist of a tax t on each worker who will find employment in the demanding sector and to redistributing the tax proceeds among the workers in the other sector. Given that we consider the commitment case, this tax t is chosen prior to any other agent's economic activity.[9]

Given the tax regime all workers have a belief about the wage m in the less demanding sector and about the wage w in the demanding sector that is paid for individuals who passed the filter. Like in the laissez-faire case, workers decide simultaneously about their individual filter effort x. Then individual success and failure is revealed and then the firms make wage offers, and production and remuneration takes place. As the individuals do not know their types before they choose their filter effort, if there is a symmetric equilibrium, they will again all choose the same effort, and an equilibrium

[8] A convincing argument has been put forward by Sinn (1996): much of the uncertainty disappears during the time period when individuals are in their education stage and too young to purchase insurance in private insurance markets.

[9] It is well known that a larger set of voter types together with the large set of possible redistributive tax schedules may even generate much more complexity, and may require restrictions regarding the set of feasibe tax schedules, as discussed, e.g., in Roberts (1977) or Meltzer and Richards (1981). For a discussion see also Drazen (2000).

that corresponds to the equilibrium that is characterized in Proposition 1 can be described by

$$\varphi'(x)(u(w-t)-u(m+s))=c \tag{5}$$

where $w=\alpha(x)h$ and $s=t\varphi(x)/(1-\varphi(x))$. We will extend the assumptions about the appropriateness of the first-order approach to the case with a tax and a subsidy, noting that the considerations become more complex by the fact that s is an increasing function of x.

The first-order condition (5) also imposes a limit to the amount of taxation that is compatible with this type of equilibrium. If the tax is too high, all workers will not choose positive filtering effort, and, instead of trying to become successfully filtered, will hope to fail in the filter.[10]

Once the first-order approach is taken for granted and the left-hand-side of (5) decreases in x, it is more straightforward to consider the choice of the tax. Both the objective function of the median voter and of a welfarist government is

$$\varphi(x)u(\alpha(x)h-t)+(1-\varphi(x))u(m+t\frac{\varphi(x)}{1-\varphi(x)})-cx \tag{6}$$

subject to (5). The choice of t occurs under a "veil of ignorance", i.e., when the workers do not know the outcome of their filtering effort. The tax t is chosen that maximizes the worker's expected utility, anticipating individually rational behavior on the side of each single worker and the equilibrium that will emerge from taxation. Hence, the government expects (5) to hold given a choice of t.

Consider the first-order condition $\frac{dW}{dt}=0$, or, using the individual first-order condition (3) and $\varphi'(x)=\eta F'_H(x)+(1-\eta)F'_L(x)$,

$$[\varphi u'(w-t)\alpha'(x)h+u'(m+s)t\Big)(-\frac{dx}{dt})=\varphi[u'(m+s)-u'(w-t)]. \tag{7}$$

As $\frac{dx}{dt}<0$ is assumed to hold, the left hand-side is positive. It is the opportunity cost of a marginal tax increase. It consists of two terms. The first effect is related to the macroeconomic externality of filtering (4), by which x is too low already in the laissez-faire. The further decrease of x that is caused by an increase in t makes this distortion larger. Note that this is a first-order

[10] The condition $h\alpha(0)>m$ also makes sure that the transition $x(t)$ is smooth, and there is no critical t that leads to a discontinuous jump from a positive effort level to zero equilibrium effort.

effect even at $t = 0$, because the laissez-faire equilibrium is distorted already. Second, the tax increase reduces x, which, in turn, reduces s for given t, and therefore reduces the redistribution gains for workers who failed the filter. This second term vanishes at $t = 0$. The right-hand side of (7) measures the usual welfare benefit from redistributing from the rich who has low marginal utility of income to the poor who has high marginal utility of income.

The marginal condition (7) reveals the main difference between filtering and straightforward investment in produtivity enhancing human capital. The optimal tax rate is not necessarily positive here. This can be seen from considering the case $t = 0$. The introduction of a small tax has a first order cost equal to $\varphi u'(w-t)\alpha'(x)h(-\frac{dx}{dt})$. It also has first-order benefits (right-hand side of (7)) at $t = 0$ as long as u is strictly concave. If u is sufficiently linear, the first-order benefit from redistribution vanishes, but the macroeconomic externality remains, suggesting that an optimal tax can be negative.

Proposition 2 *The equilibrium income tax that is chosen by the median voter can be positive or negative, depending on the size of the macroeconomic externality of filter effort and the concavity of utility of income.*

Intuitively, if there is a positive externality of filtering effort, filtering effort should be encouraged. However, the insurance aspect of redistributive taxation suggests a tax. If two instruments are available, the government could then pay each individuals' effort for the optimal amount of filtering, and then equalize incomes ex-post. This way the government could implement the first-best, and this would also be the choice of the median voter from an ex-ante perspective, not knowing whether he will gain or lose in the filtering process. However, given that filtering effort is not observable, the subsidy is not feasible, and this leads to the trade-off with respect to redistributive taxation.[11]

[11] The ex-ante choice of the median voter and of a welfarist government coincide here. This potentially changes if the government cannot commit to the amount of redistribution that is carried out once the individuals have chosen their education efforts and their filtering success is observed. The ex-post choice of taxation by a welfarist government or by a median voter differ from these ex-ante choices described in this section. Also they are likely to differ from each other.

5 Overconfidence

In what follows we will introduce a further problem into the analysis: wrong perceptions about own ability. Based on the strong psychological evidence[12], there has been a considerable literature on the role of self-confidence in various contexts of economics more recently. At least four studies are closely related to the filtering aspect in this paper, even though they do not touch upon the public finance perspective of optimal taxation. Sjögren and Sällström (2001) consider education choices by individuals who differ in their prior beliefs about their productivity. In particular, they show that uninformative (safe) options can trap individuals below their potential. More importantly, individuals' perceptions about the variance by which their true ability is spread around its expected value matters for their carreer decisions, in particular if these decisions are dynamic, and learning plays a role. Krähmer (2002) considers the role of overconfidence in repeated tournaments between two contestants in which the contestants learn and update their beliefs about themselves and about their competitor. He shows that there is a tendency of such tournament series to end up in some absorbing beliefs in which one of the two contestants basically exits, leaving the flow of future prizes to the presumably stronger contestant, and where the perception of strength may be and stay wrong forever.

Squintani (1999) considers a signaling model in which workers repeatedly can take pass-fail tests where the test result can be observed error-free. Workers choose the difficulty of the test in a respective period. Workers differ in their ability, and also have a prior belief about their ability. If their beliefs are correct, there is a separating equilibrium in which more gifted workers choose a more demanding test, and separation occurs, basically in the first round. If some individuals have wrong beliefs, the situation is more complex, as learning about true ability plays a role.

Flåm and Risa (2003) consider a related framework. There, individuals differ regarding their true ability, and they have a belief about their ability, which may, but need not be correct. They can take a series of (identical) tests in which they obtain a test score. Whenever they stop the series of tests, their wages will be a function of the history of scores. In the simple case in which the test only has two possible scores, success and failure, their decision to continue the series of tests will be a function of previous scores and their subjective belief about their talent. In turn, the subjective belief

[12] The most relevant evidence in this context is the "better than average" effect that has been documented, e.g., by Guthrie, Rachlinski and Wistrich (2001) with respect to judges' assessment of their decisions, or with respect to driving skills by Svenson (1981). Further references can be found, for instance, in Squintani (1999) and Heifetz and Spiegel (2000).

about their talent is a function of the history of scores. Giftedness and high confidence will lead to a long series of tests in expectation. A main difference between their analysis and Squintani (1999) is the test technology. Whereas in Squintani (1999) choose the difficulty of their test in each round, the test in Flåm and Risa (2003) is uniform for all individuals and in all periods, explaining why more separation in a first round of tests can happen in Squintani's (1999) analysis than in Flåm and Risa (2003).

Flåm and Risa (2003) apply their framework to explain positive correlation of income between parents and children. If the parents' income level positively influences the child's confidence, a high parental income leads to a high confidence level. Particularly if the wage in the equilibrium does not depend on the whole scoring history, but only on whether the applicant failed or succeeded in the last test, children with parents with high income tend to choose a more aggressive stopping rule regarding the tests, and are more likely to end up with a success.

The analysis in our paper is entirely static, removing aspects of Bayesian updating and learning from the picture. We restrict attention to a one-stage test of given difficulty, and the test will have only two scores: success and failure. The additional dimension we add is that the individuals must choose how much effort to spend on this test. Effort favorably influences the probability of success, and this effort cannot be observed by others. If a worker overestimates his own probability of belonging to the productive group, he chooses effort accordingly, which may induce him to spend more effort than is individually optimal. Hence, overconfident individuals tend to spend more than their individually optimal filter effort. This has general equilibrium implications. The overconfident worker is more likely to succeed in the filter, but at inefficiently high cost. Moreover, the overconfident worker generates a positive externality for individuals who are not overconfident, and also increases their equilibrium filter effort.

Turning to the formal analysis of overconfidence and filtering, suppose some workers are overly confident about their own probability of belonging to the $H-$types. Let η still be the share of workers who are able to perform the more demanding task. Further, let there be a share χ of the workers that is randomly drawn from the set of all workers, and let this share subjectively believe that their own probability of being of type H equals $\hat{\eta} > \eta$. This χ is the share of *overconfident* workers. The remaining share $(1 - \chi)$ is assumed to have correct beliefs about their own type; we call them *just confident*. As is common in the literature on overconfidence that is discussed in the introduction here, we do not ask the question where these beliefs come from and take them as exogenously given.

We must further make assumptions about what workers believe about

the distribution of their co-workers and their beliefs. For this purpose we will assume that all workers and all firms have the same and correct beliefs about the aggregate share of $H-$types, but all know that there is a share χ of workers each of whom is overconfident about his own probabilily of being of type H.

Consider the equilibrium. Suppose again that contracts that are contingent on the individual productivity of workers in the demanding task are not feasible, for instance, because output is only observable on the aggregate level and there are many workers, and let w be the equilibrium wage in the demanding task. Then the just confident workers choose an x that is still determined by (3). The overconfident workers choose an x that is determined by the marginal condition

$$[\hat{\eta}F'_H(x) + (1-\hat{\eta})F'_L(x)](u(w) - u(m)) = c \tag{8}$$

As $F'_H(x) > F'_L(x)$ this implies that overconfident workers choose more filtering effort than just confident workers. Let their filtering effort be $\hat{x}$. The new share of individuals who pass the filter is

$$\varphi(x, \hat{x}) = \chi\varphi(\hat{x}) + (1-\chi)\varphi(x)$$

and the share of $H-$types among those who pass the filter successfully is

$$\alpha(x, \hat{x}) = \chi\alpha(\hat{x}) + (1-\chi)\alpha(x).$$

Proposition 3 *(i) Overconfident workers choose higher effort than just confident workers. (ii) Just confident workers choose higher filtering effort in the equilibrium if there is a positive share of overconfident workers. (iii) Just confident workers benefit from overconfident workers.*

This can be seen as follows. (i) follows from the comparison of (3) and (8). (ii) can be shown as follows. Suppose they choose the laissez-faire filtering effort as derived in section 2, and denote this as x^*. Then, because (ii), $\hat{x} > x^*$, and overall $\hat{\alpha} > \alpha^*$. This will drive up the equilibrium wage in the demanding sector and, in turn, x^* is not an equilibrium choice. A larger x is required to fulfill (3). (iii) Given this larger x chosen by all others, each just confident worker could continue to choose x^*, have the same effort and earn higher wages in expectation than in the absence of overconfident workers. The fact that each worker who is just confident chooses a different x implies that he is even better off than by choosing x^*. □

Proposition 3 shows that overconfidence may compensate for the underprovision problem of filtering effort. The outcome is never first-best in terms

of maximizing the expected ex-post utility of workers, however, because there is only one optimal effort, and the overconfident and the just confident workers choose different effort levels. For any given equilibrium levels of the effort choices of these two groups, they could choose some appropriately weighed average of their effort choices and transfers between them and could thereby improve their joint welfare.

Overconfident individuals generate some 'noise' and often make signals in the market potentially less valuable. This has been highlighted in a related context by Squintani (1999). Here, the overconfident individuals do generate some noise as well in the following sense. As they spend more effort than just confident workers, the group of overconfident workers allone generates a signal that has higher precision than the signal produced by the two groups together. As the confidence of a worker and his effort level are unobservable, the successful workers are of heterogenous expected quality. However, the higher effort of overconfident workers generates a positive externality to all other individuals, including the just confident workers. This explains why individuals who have correct beliefs about their competence benefit from overconfident workers.

Proposition 4 *The overconfident workers earn a higher expected wage, but their expected ex post utility is lower than the expected utility of just confident workers in the equilibrium.*

For a proof consider an overconfident worker. If he chose the effort that maximizes his expected utility given the true probability of being of type H, this yields a higher expected utility to him. Moreover, the excessive effort that overconfident workers spend makes them end up with higher filtering success. Therefore, their expected income is also higher than the expected income of just confident workers. □

Applying proposition 4 to professional sports and other areas in which superstars play a major role, proposition 4 suggests that overconfidence is an important factor in becoming a superstar. Those who do not try very hard will be less likely to pass the filter. However, the sacrifice that the overcompetent make in this lottery is excessive. They are not compensated for their tremendous effort by the expected reward, at least not ex post.

Successful individuals are, on average, more likely to be confident than unsuccessful individuals, due to Bayesian updating. However, they are also more likely to be overconfident, as there is a self-selection of overconfident individuals in the filtering process, due to the higher effort chosen by the overconfident.

6 Overconfidence and redistribution

Finally we discuss the issue of overconfidence and taxation. With a homogenous population of just confident voters and an ex-ante choice of taxes, the median voter's, or more generally, the decisive voter's choice of a redistributive tax and the welfarist tax are identical. With heterogenous voters this will typically not be the case. In addition, with overconfident individuals one has to distinguish between optimality ex ante and ex post: A homogenous population of overconfident individuals unanimously agrees on a tax that differs from the tax that a government implements that knows about the perception bias and that tries to maximize the expected utility of the representative individual regarding ex-post outcomes. Whether a welfarist government should implement a policy that maximizes the ex-ante expected subjective utility of the population that is calculated using their misperceived probability estimates, or whether it should maximize expected utility using "true" probabilities, is not clear. For this reason we do not pursue the issue of optimal taxation in the framework in which individuals have misperceptions about their own abilities and concentrate on comparing the tax choices made by a just confident decisive worker and by an overconfident decisive voter.

The decisive voter first chooses t, then all workers choose their efforts. Accordingly, for the outcome it depends whether this voter is just confident or overconfident. The objective function of a just confident voter is

$$W = [\eta F_H(x)+(1-\eta)F_L(x)][u(\alpha h-t)-u(m+t\frac{\varphi}{1-\varphi})]+u(m+t\frac{\varphi}{1-\varphi})-cx, \tag{9}$$

subject to (5), where α, φ are equilibrium values. They do not depend on the decisive voter's own choice of x, and are also independent of this voter's type, as all voters have correct beliefs about the distribution of types. However, α and φ depend on the choices of all voters' x as in (1) and (2). As x is a function of t, the values of α and φ eventually depend on t, with x is determined by (5) for the just confident type.

Similarly, the objective function of an overconfident voter is

$$\hat{W} = [\hat{\eta} F_H(\hat{x})+(1-\hat{\eta})F_L(\hat{x})][u(\alpha h-t)-u(m+t\frac{\varphi}{1-\varphi})]+u(m+t\frac{\varphi}{1-\varphi})-c\hat{x}, \tag{10}$$

with $\hat{x}$ determined by

$$[\hat{\eta} F'_H(\hat{x}) + (1-\hat{\eta})F'_L(\hat{x})](u(w-t) - u(m+s)) = c \tag{11}$$

for overconfident workers.

A first observation that can be stated as a proposition is as follows:

Proposition 5 *A positive tax rate $t > 0$ with $w-t > m+s$ in the equilibrium redistributes income from the group of overconfident workers to the group of just confident workers.*

Proof. As is clear from section 5, as long as redistribution does not lead to net incomes that reverse the ranking of gross incomes, overconfidence will make the overconfident spend more effort in education than the just confident person. As shown in Proposition 3 this implies that the share of overconfident workers who are successful in the filter in the equilibrium exceeds the share of successful and just confident workers. ■

The result in proposition 5 suggests that, for the same and given shares of just confident and overconfident workers, a decisive voter who is overconfident may choose a lower tax rate than a decisive voter who is just confident. However, the comparative static results on this are inconclusive. As the result is inconclusive, and for this reason we do not report the formal results in detail. However, an intuition explaining why the results are inconclusive is as follows. Let us start from the tax $\hat{t}$ that an overconfident worker would choose. A just confident voter may want to choose a different tax for several reasons. First, given his different probability estimates regarding his success in the filter, his demand for redistribution as a means of insurance is higher than for overconfident workers. This, in isolation, points at a higher tax rate chosen by the just confident workers. Second, an increase in the tax has further incentive effects and distributional effects. It discourages both types' filtering effort. This reduces the gross wages of workers who are successfully filtered and it reduces the overall share of successful individuals both among the just confident and among the overconfident types. It may but need not reduce the share of successful individuals who are overcompetent disproportionally. If it does, it may therefore reduce the amount of redistribution from the overconfident group to the just confident group. This effect taken in isolation may suggest a lower tax rate.

To illustrate these countervailing effects further, consider the simple case in which almost all workers are overconfident. The overconfident median voter chooses t in this case such that

$$\left[\hat{\varphi}(\hat{x})u'(w-t)h\alpha'(\hat{x}) + (1-\hat{\varphi}(\hat{x}))u'(m+s)\frac{\varphi'(\hat{x})}{(1-\varphi(\hat{x}))^2}\right]\frac{d\hat{x}}{dt} \quad (12)$$
$$+\left[\hat{\varphi}(\hat{x})u'(w-t)(-1) + (1-\hat{\varphi}(\hat{x}))u'(m+s)\frac{\varphi(\hat{x})}{1-\varphi(\hat{x})}\right] = 0$$

where $\hat{x}$ is the filter effort chosen by an overconfident voter in the resulting equilibrium, and $\hat{\varphi}(\hat{x}) = \hat{\eta}F_H(\hat{x}) + (1-\hat{\eta})F_L(\hat{x})$. Condition (11) has been used to obtain (12) from an overconfident decisive voter's objective function

with respect to the tax. Let $\hat{t}$ be the tax solving (12). A just confident worker would benefit from a small increase in the tax given that almost all workers are overconfident, if

$$+\left[\varphi(x^*)u'(w-t)h\alpha'(\hat{x})+(1-\varphi(x^*))u'(m+s)\frac{\varphi'(\hat{x})}{(1-\varphi(\hat{x}))^2}\right]\frac{d\hat{x}}{dt} \quad (13)$$
$$+\left[\varphi(x^*)u'(w-t)(-1)+(1-\varphi(x^*))u'(m+s)\frac{\varphi(\hat{x})}{1-\varphi(\hat{x})}\right]>0.$$

The second term in these equations measures the insurance benefit of additional redistributive taxation, and this term is higher for the just confident worker as $\varphi(x^*)<\varphi(\hat{x})<\hat{\varphi}(\hat{x})$. Note that this term also accounts for the fact that there is some redistribution from the group of overcompetent workers to just competent workers in expectation. However, the first two terms in the conditions (13) and (12) are more difficult to compare with each other, as their relative size depends on the filtering externality that is captured by α' and on the effect of the tax increase on the share of successfully filtered workers. Even the simple comparison in which the group of just confident workers has a measure of zero therefore is inconclusive.

7 A few more issues

The analysis up to this point has been restrictive along several dimensions. In this section we will briefly consider how the results change or extend if some assumptions are modified, always starting from the benchmark case without redistribution and without overconfidence.

Private insurance The analysis did not consider the agents' option to privately insure. While there are good reasons (see, e.g., Sinn 1996) to concentrate on this case, it is worthwhile to discuss the case in which individuals first choose the amount of insurance they purchase on actuarially fair insurance markets in a stage prior to the choice of the redistributive tax.

Private insurance and the desire for redistributive taxation interact. It is instructive to first consider private insurance if there is no later redistributive taxation. If there is an insurance market in which competition leads to actuarial fairness, and if the insurance companies cannot observe individuals' education efforts, the insurance problem of each individual can be described as the problem to maximize

$$\varphi(x)u(\alpha h-t)+(1-\varphi(x))u(m+s)-cx.$$

The insurance companies anticipate an equilibrium choice of x for all individuals that is a function of t and fulfills $s = t\frac{\varphi(x(t))}{1-\varphi(x(x))}$. However, given that the individual choice of x is not observed, the first-order approach determines the optimal t as the solution to

$$[u'(m+s)t\frac{\varphi'}{(1-\varphi)}](-\frac{dx}{dt}) = \varphi[u'(m+s) - u'(w+t)].$$

Individuals optimize almost like when choosing redistribution, but without taking into consideration the filtering externality. Hence, private insurance leads to more insurance than the optimal amount of redistributive taxation, if the filter improves with an increase in filter effort. From the individual point of view, there is overinsurance in a fully competitive private insurance market, because the spillover effects of filtering effort are not taken into account when the private insurance decision is made.

One may then ask how private insurance and optimal redistribution interact. If individuals chose private insurance naively, not anticipating redistributive taxation, they will then unanimously agree to redistributive taxation that transfers income from the low income earners to high income earners in order to address the filtering externality. If this is anticipated in turn, they will choose even more private insurance. More generally, as long as the choice of redistributive taxation can be undone by private insurance choices, it will be very difficult to correct for the positive externality of filtering effort.

Time consistent taxation As discussed in Boadway, Marceau and Marchand (1996), the time lag between education effort and the time periods when this effort pays off may make it difficult for politics to commit on a tax policy that is optimal from an ex-ante point of view.

Ex post the education effort is given. A welfarist government then has an incentive to fully equalize income differences. Boadway, Marceau and Marchand (1996) suggest to make education mandatory to overcome the hold-up problem. The same problem also arises where filtering effort replaces education effort. Accordingly, the suggested remedy is also similar: the government may want to introduce mandatory filtering. Practically, this may be very difficult, given that filtering effort is (assumed to be) unobservable.

The outcome of time consistent redistributive taxation in the political process is more difficult to determine and very much depends on whether the decisive voter belongs to the group of workers who succeeded in the filtering process, or to the less successful group. In turn, this can generate multiple equililibria with self-fulfilling expectations. If individuals believe that the future decisive voter has been unsuccessful in the filter and works in the less

demanding task, they anticipate high redistributive taxation and hence may abstain from spending much filtering effort which, in turn, may lead to an outcome in which the decisive voter has been unsuccessful. If individuals anticipate that the decisive voter will belong to the successful group, they anticipate that there will be little redistribution, which gives each worker strong incentives to filter. Accordingly, the decisive voter may indeed belong to the group of successful workers, and this voter's choice of redistributive taxation then justifies the voters' expectations.

Productive human capital investment Most likely, education is a filter, but not only a filter. Some skills can be learned and some information can be acquired that makes a person more productive in a given job. For instance, a tax consultant who has to take a very demanding examination in order to be admitted to the profession is probably more able to give advice if he studied tax law in detail than without any familiarity with the tax law. However, this fact should not generally invalidate the results on education as a filter. As long as education also has a function as a filter, and as long as the increase in effort increases the precision of the information about ability that is generated by the filter, there is a positive externality of filtering effort that leads to an inefficiency in the amount of filtering effort. Problems of investment in education that enhances productivity directly simply add to the filtering problem that we considered in more detail.

Signaling and screening A large share of the literature on education investment addresses education investment that is used as a signal to overcome an information asymmetry. In order to be at work, this mechanism requires that employers can observe the educational effort of future workers possibly leading to excessive investment in education. It is just the element of unobservability of effort that we concentrate on that generates the externality of filtering effort and that leads to the underprovision of effort in the framework we consider. Observable education as a signaling device on the one hand and unobservable education as filter effort may be used at the same time, and there is no general contradiction between overprovision of observable education investment and underprovision of education effort as a filter.

Throughout the paper we assumed that employers cannot observe the individual performance of workers in the demanding task. If they could, they could use incentive contracts that induce their own workers to choose more filtering effort. By this they could partially overcome the moral hazard problem, and in the absence of risk aversion they could even fully internalize this aspect.

Moreover, if some individuals have misperceptions about their a priori probability of being of type H, and therefore choose different education effort than individuals with correct beliefs, employers would like to pay different wages to just confident and to overconfident workers, even though they have the same a priori probability of being of type H, if they choose different filtering efforts in the equilibrium. The employers may then want to screen workers and offer a menu of contracts specifying the wage as a function of individual productivity. As this adverse selection problem and the moral hazard problem in the previous paragraph interact, the equilibrium solution becomes non-trivial in this case.

However, we think that it is plausible that individual performance is not easily observed in many firms and working environments, justifying the assumption that is made in the paper that payment on the basis of individual performance is not feasible.

8 Conclusions

As has been pointed out by Kenneth Arrow (1973), education typically has aspects of a filter that contributes to solving assignment problems. This paper considers the political economy of redistributive taxation if the role of taxation is confined to this filter aspect and shows that the externality of filtering suggests the choice of less redistribution. We also show that overconfidence may partially correct for the underprovision of filter effort. Moreover, overconfident individuals are more successful than just confident individuals in this context, but they spend too much resources on generating this success. Moreover, just confident individuals benefit from these overconfident individuals. Finally, we show that overconfidence changes the results on redistributive taxation, making it even unclear whether the just confident workers prefer higher or lower redistributional taxes than overconfident workers.

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